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Examining the Effectiveness of Climate Change Coping Strategies in Enhancing Household Food Security: A Case Study of Nyika Farming Block in Petauke District.

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Abstract
This research aimed at 'Examining the effectiveness of climate change coping strategies in enhancing household food security; A case study of Nyika farming block in Petauke.' The agriculture sector in Zambia has been experiencing hostile effects of climate change which is shown by increased frequency and severity of seasonal droughts, unstable distribution of rains, increased temperatures, and seasonal floods in some areas. This has resulted in deepened poverty levels, particularly food insecurity among 47% of grain SHFs who are vulnerable to climate change shocks. The study had the following objectives: To examine the level of awareness among small scale farmers on the effects of climate change; To determine the innovations used by small scale farmers in enhancing household food security; To establish agricultural strategies used by small scale farmers to reduce the effects of climate change and; To determine Government measures to be taken to reduce climate change effects. The methodology adopted was a descriptive case study and targeted small scale farmers from one farming block in Petauke district. The study showed that many farmers were aware of climate change and some of its consequences. It also found that farmers applied agricultural adaptation strategies including; multiple cropping, informal seed systems, traditional agroforestry, dry season gardening and dry planting. The study has further shown that farmers used different combination of strategies which are innovation based like are application of conservation agriculture (10%), erosion control (18%), grazing management (16%), water storage systems to conserve water (8%), drip irrigation (14%), use new water management systems (12%) and the rest early land preparation (22%). It was discovered that the government has put in measures to impede climate change effects but need reinforcement in terms of manpower and resources. The study concluded that the strategies used by farmers to cope with the changes in climate are effective if applied accordingly, these strategies have helped small scale farmers to enhance household food security. The study recommended that: Government ought to develop strategies on how Meteorological Department in collaboration with the Ministry of Agriculture can improve localized information delivery on weather and climate change to the farmers; There is need of involving key stakeholders which will enhance the dissemination of correct and timely climate and weather information to small scale farmers more preferably translated into the local language; The government ought to discourage charcoal burning by encouraging alternative sources of energy for cooking e.g. gas stove, cow dung, cheaper solar equipment; and fining charcoal vendors to discourage the charcoal business from growing; Government and partners need to fund more scientific strategies among farmers through acquisition of more transportation vehicles like bicycles and motorcycles for extension officers to reach farmers regularly and fund farmer groups with equipment like pumps for irrigation.

Key words – effectiveness, climate change, coping strategies, household, food security

1.0. INTRODUCTION

1.1.Background

Climate change is one of the global challenges being experienced today. It is considered to have remarkable effects on the quality of human livelihoods, particularly of rural populations in developing economies that are subject to increasing vulnerability (Intergovernmental Panel on Climate Change (IPCC) 2001, 2007, and 2013). Its impacts are felt across all sections of society and all sectors of economic development. Perhaps, the most directly affected sector is rain-fed agriculture (Fussel et al., 2006; Sheffield et al., 2014); and because of this, indigenous communities' dependent on agricultural livelihoods are likely to be the most affected (Sheffield et al., 2014). On a global scale, there is overwhelming scientific evidence of rising atmospheric temperatures while precipitation is mainly documented to be variable in time and space (Libanda et al., 2020; Hansen et al. 2016; IPCC., 2014). Empirical evidence by Neupane (2009) and Libanda (2020) indicates that extreme weather events like hotter summer months, very hazy winter, erratic rainfall, and storms have become more frequent. This has negative impacts on sustainable development as most of the developing countries depend on rain fed agriculture.

There is particularly more need for critical attention to climate change in developing countries whose economic rhythms are mainly dependent on rain-fed agriculture (Libanda et al., 2020). This means that, while the impacts of climate change are global, the negative impacts are more severely felt by developing countries like the Sub-Saharan African (SSA) countries. This is because of their vulnerability to climatic variability and dependence on natural resources for their livelihoods with limited capacity to cope with climate variability (Cleugh et al., 2011). The fourth assessment report by the IPCC (2007) indicates that "anthropogenic activities increase the amount of Greenhouse Gases (GHGs) in the atmosphere". It further shows that human activities have contributed to the increased emissions of GHGs by 70 % from 1970 to 2004. The increased accumulation of these gases in the atmosphere directly influences air circulation and rainfall patterns, which poses a great threat to the environment and food production (Beddington, 2010; IPCC, 2014). According to IPCC (2014), this will result in exacerbated food insecurity, rising sea levels, increased frequency and intensity of extreme weather events (e.g. floods, droughts, heat waves); more species extinction, and reduced biodiversity.

SHFs play an important role in contributing to achieving United Nations' Sustainable Development Goals (SDGs) Number One and Number Two which emphasize on ending poverty and hunger, respectively, by 2030.Muller et al. (2011) posit that small-holder farming is the best tool to ensure global food security which is proven to be sustainable and plays a vital role in poverty eradication and ensuring food security. Therefore, maximization of the opportunities and minimization of the risks of small-holder farming is crucial as noted by Lowder et al (2016).

1.2. Statement of problem

The agriculture sector in Zambia has been experiencing hostile effects of climate change which is shown by increased frequency and severity of seasonal droughts, unstable distribution of rains, increased temperatures, and seasonal floods in some areas. This has resulted in deepened poverty levels, particularly food insecurity among 47% of grain SHFs who are vulnerable to climate change shocks (Ahmed et al., 2007). Recurrent droughts in Southern Province have compromised its agrarian economy. The livelihood of the farming community has been exposed to serious limitations on food security and agriculture development among SHFs who depend on rain-fed agriculture (Ahmed et al., 2007). According to Mulenga et al., (2019) maize productivity has been affected in the central and northern regions, which account for 50–60 percent of total maize production in the country. The largest

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negative climate change impacts on yields have been experienced in the southern and western regions, which account for roughly 26% of agriculture value added. Despite efforts made by government and other stakeholders, some of the interventions have shown low adoption rates by SHFs (Salick and Byg, 2010). According to Kinkase (2017), key knowledge of locally adopted strategies is not fully utilized in the designing and development of sustainable district agriculture plans. This makes the local farmers more vulnerable as some of the strategies imposed on them cannot be applied in certain districts (Kinkese 2017). Thus, the study bridges the knowledge gap in the available literature on the effectiveness of climate change coping strategies in enhancing household food security.

1.3. Objectives

Specific objective

To examine the effectiveness of climate change coping strategies in enhancing household food security

Specific objectives

i. To examine the level of awareness among small scale farmers on the effects of climate change
ii. To determine the innovations used by small scale farmers in enhancing household food security.
iii. To establish agricultural strategies used by small scale farmers to reduce the effects of climate change
iv. To determine Government measures to be taken to reduce climate change effects

1 4. Research Questions

i. What is the level of awareness among small scale farmers on the effects of climate change?
ii. What innovations are used by small scale farmers in in enhancing household food security?
iii. What agricultural strategies are used by small scale farmers to reduce the effects of climate change?
iv. What measures can government take to reduce climate change?

1.5 Conceptual Framework

The developed conceptual framework provides the relationship and interactions between variables and further illustrates how the changing climatic conditions have led to the observed climate variability impacts which have limited the SHFs' livelihood options. Primarily, farmers are exposed to external factors like climate change impact, governance and policies. These factors influence farmers' decisions on farming and adaptation practices to climate change. The adaptation practices that farmers choose to use as they react to climate change impact have some implications on the livelihoods of the people. Depending on the choice of the adaptation strategy chosen, the socio-economic is affected either positively or negatively, which in turn affects the climate system including the GHGs concentration in the atmosphere.

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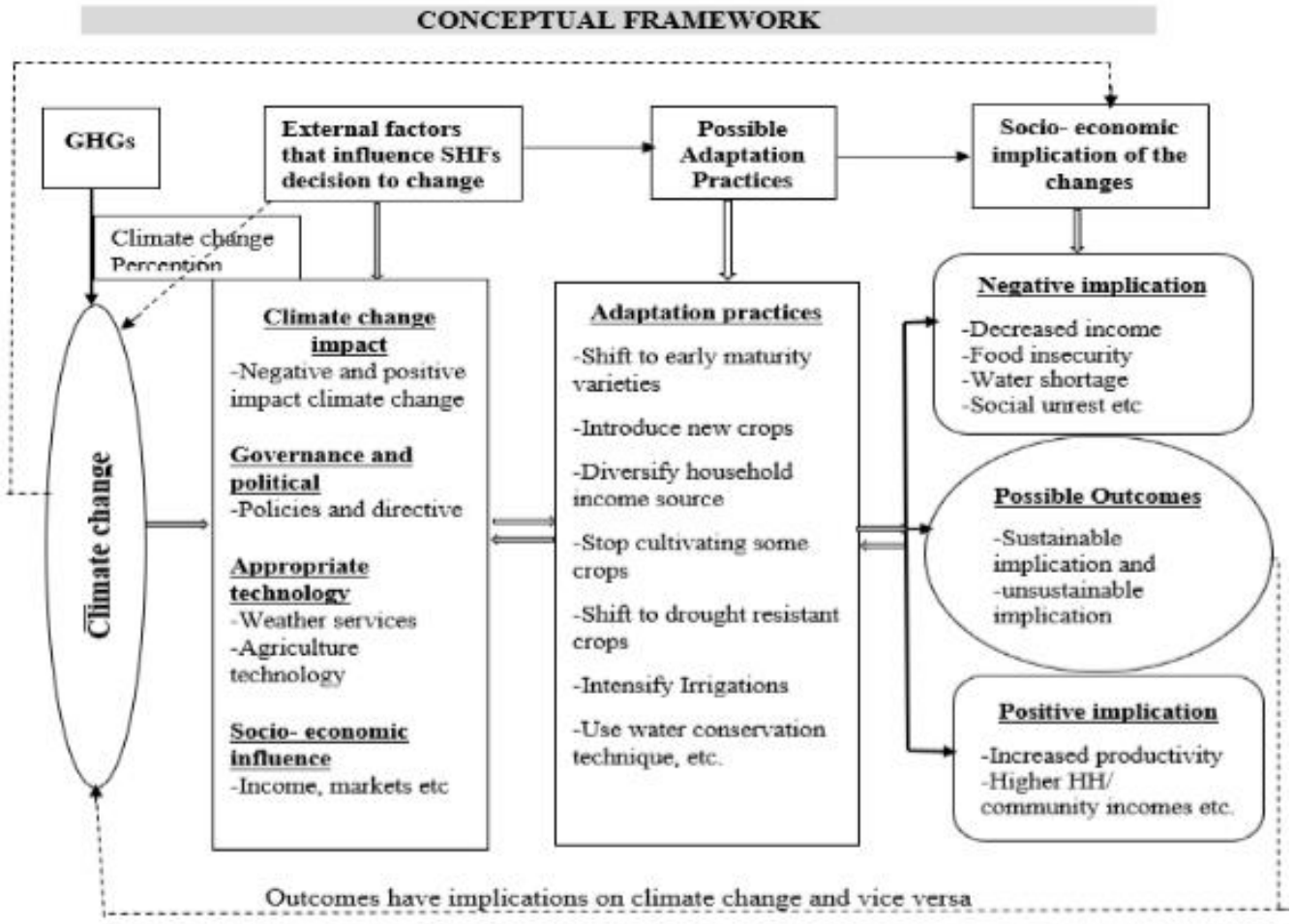

Figure1: Conceptual framework for climate change and adaptation practices

Source: Adapted from REMA (2011).

2.0 LITERATURE REVIEW

Overview

This chapter therefore presents studies done by other researchers, the discussion is guided by the study objectives and each theme is discussed form global perspective, African perspective and finally local perspective.

Level of awareness among small scale farmers of effects of climate change

According to the baseline survey result on awareness and knowledge level done by SCW in early 2011, the majority of people in Teuk Krahorm commune are realized the changes in higher temperature, changes in time of rain, frequent or intense droughts and frequent lightning. They claimed that deforestation is the main cause of climate change. Over 50 percent of respondents did not know the cause. With regard to climate change impacts, people realized that they have been suffered from rice yield reduction, problems of human and animal health, food and water shortages and income loss. The majority of respondents claimed that the poor and children are the most vulnerable to climate change. They lack of money, irrigation system, improved rice variety, and challenging in health issues. They have no ability to cope with climate change impacts. 55 percent of respondents are realized that women are the most

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vulnerable to climate change due to their big burden in housework, difficulties in accessing to good quality of water and their involvement in agricultural activities UNDP, 2012).

Based on the result from the UNDP (2012) study of group discussions, farmers, commune councilors, district and provincial officers have been observing the changes in climate such as higher temperature, intense rain and strong wind, intense lightning, drought and changes in timing of rain. This year, they have observed that rainy season comes late and farmers normally plant seedlings in May. They added that there were clouds with strong wind, but there was no rain or less rain. In 2011, there was flood in Pring Thom commune, Yeang commune and Romdoh Sreh commune, Commune councilors and district officers added. Farmers who were not involved in the campaign have the same observation as those who engaged in the campaign. With regards to the causes of climate changes, people realized various contributions to climate change such as forest degradation, emission from factories, waste, chemical fertilizer application, air-conditioner, refrigerator, spray, animal dung. Commune councilors mentioned that the forest in the areas have been cleared illegally by farmers who need more farming land and by the militaries. The forest cut down includes resin trees that people get benefits from. Groups of district and provincial officers added that causes of climate change include emission from factories in developed countries, big farms, extractive industries, chemical use and forest clearing for farming without conserving forest cover. For the groups who did not participate in the awareness campaign, they said loss of forest, smoke from cars and factories are cause of climate change. Majority of people interviewed in the group discussions said they used to hear the word "Greenhouse Gases". They claimed that greenhouse gases are from machinery, car, motor, burning plastic bags and animal dung. However, most of them except those in Tuek Krahorm commune could not clarify what the greenhouse gases are. Commune councilors said that smoke from factories, animal dung, waste dump, burning plastic bag and water vapor are greenhouse gases (UNDP, 2012).

Innovations used by small scale farmers in combating climate change

Smallholder farmers in Algeria are currently required to raise agricultural production while using fewer resources (such as less energy and more water) and under more constraints (e.g., an increase in temperatures, soil salinity and desertification). A number of CSA practices have been initiated and implemented, such as water saving, construction of dams and hill reservoirs, fight against erosion and desertification, anti-drought programs, protection and rehabilitation of steppe lands and preservation and extension of forests (Devkota et al., 2022). Here are some examples of climate-smart innovations in the agricultural, livestock and forestry sectors, financial resources and policy evolution. To avoid these problems and to enhance investment and trade in a modern, sustainable horticulture sector, Algeria has collaborated with the Netherlands to realize a practical greenhouse system best suited to the local harsh arid environment.

Adaptive greenhouse systems are based on what is called the SmaSH concept of GHI, which stands for smart sustainable horticulture and aims to optimize greenhouse designs to one specific setting, climate conditioning, greenhouse climate control, substrates and nutrition control (Devkota et al., 2022). Since then, farmers have widely used this mode of production (using greenhouses) which has allowed them to increase their yields in a very significant way. Another strategy developed by smallholder farmers, especially in the semi-arid regions of Algeria is the integration of crop–livestock systems (ICLSs). This system is centered on interactions between animal and crop activities which are temporal and spatial. This strategy is considered a conservative farming practice based on minimum mechanical soil disturbance and the permanent cover

of soil using crop residues and/or cover crops. This is also coupled with the diversification of crops using a crop rotation system (Devkota et al., 2021). ICLS practices under conservation agriculture principles have contributed positively to growth yield and the reduced climate vulnerability of farmers, promoted more diverse on-farm crops and reduced market fluctuation vulnerability (in terms of fuel, seeds, feed resources, labor, seeds, etc.).

Strategies used by small scale farmers to cope with changing climate

Adaptation has been playing an important role in ensuring food security among SHFs who respond to climatic changes in different ways. People in different societies have been adapting to climate change and variability by changing various aspects of their lifestyles, such as their settlement and agricultural practices as well as their economies (Adger, 2005). SHFs respond to climate change by using either local or introduced adaptation strategies. However, the ability of SHFs to make informed decisions is largely governed by some personal experiences acquired over the years. In the absence of any credible scientific knowledge systems, SHFs autonomously resort to the use of local knowledge-based adaptation strategies (Maddison, 2007).

According to the study done by FAO (2021) as stated by Rice Research and Development Institute, farmers cut back total irrigation requirements for rice cultivation per season by 10 to 20 percent by adopting new water management practices. This allowed them to store water for the next cropping season. All farmers of the Meegassegama reservoir initiated land preparation early (at the beginning of the rainy season), instead of waiting for water reservoirs to fill and irrigation water to be released from the reservoir. Farmers were able to expand land under irrigation by 15 percent during the dry season. This expansion was made possible by the training received by farmers in the alternate wetting and drying technique, which allows them to save water during the main growing season.

Government measures used to reduce the effects of climate change

Climate change is now manifesting itself with great intensity, and the current global financial crisis, has just accentuated the vulnerability of farmers, and others whose livelihoods are closely linked to climate and natural resources. Initiatives are urgently needed to help small scale farmers and other vulnerable groups to protect and promote sustainable agricultural production (Andrieu, 2021). Simple, inexpensive actions could be taken, such as setting up an effective meteorological and early warning systems, improving agricultural extension services so as to increase crop yields, and establishing local networks of information exchange for communities (Jones, 2003).

FAO (2021) in their case study in Italy have revealed that farmers in Italy have demonstrated that innovative solutions are more easily obtainable if researchers and policymakers collaborate towards a common goal. With 70 percent of rural development projects in the region being oriented towards CSA, it comes as no surprise that innovation has become a key term in the region's agricultural policies. Rural development measures are promoting CSA practices to help farmers adapt to and mitigate the effects of climate change, thus changing the agriculture sector's image of polluter (Adger, 2005). In addition to funding projects under Measure 16.1, Emilia-Romagna has formulated actions under Measure 16.2 ("Support for pilot projects and for the development of new products, practices, processes and technologies") to take the promotion of CSA one step further (ibid). According to FAO (2021) this measure supports projects that concern entire supply chains. Eight of the 25 animal production projects and 9 of the 30 plant production projects financed under this measure involved the adoption of CSA practices. Overall, the OG projects in Emilia-Romagna have been shown to promote climate change-related innovation in agriculture and food production. Thirty-five percent of the projects aim at

mitigating the effects of climate change, 21 percent promote climate change adaptation, 11 percent concern carbon sequestration and 33 percent combine adaptation and mitigation efforts. Strategic investments in specific sectors are key to achieve results on a macroscopic level.

Personal critique of literature

Rogers (2003), Lorenzoni and Pidgeon (2006) and Dhaka, Chayal and Poonia (2010) found personal experience and knowledge to be crucial factors in improving awareness and knowledge. The findings of this study affirm that, although farmers do not adequately understand climate change, they are adapting. Education to increase their resilience and for them to embrace effective mitigation and adaptation measures should be aimed at fostering their understanding and interpreting climate change indicators which are more discernible to farmers in their locale and less provision of scientific indicators which are hard to fathom. Ngetich et al. (2022) conducted a study in Kenya on adaptive strategies used by small scale farmers in Kanya. Based on the results of this study, there were lessons learned on how the farmers adapted to climatic variability. As shown by the various adaptation strategies adopted by the farmers, the farmers could adjust their livelihood strategies to the variations in climate, both short and long-term. Farmers can make sound decisions on what to plant, field management, such as when to plant and agronomic practices, and the general tendency to diversify production systems. Such strategies as intercropping, planting of cover crops, and construction of water harvesting structures were employed in all the study areas.

Established gaps

Despite a number of studies concerning climate change are conducted, there is limited information in Zambia regarding the level of awareness among small scale farmers on the impact of climate change. Some studies which have been conducted lack the much needed information because they focus on general climate change.

4.0 RESULTS/FINDINGS

Overview

Table 2: Age group (years)

Age group (years)		
Between 35 and 40	Between 41 and 50	51 and above
2%	55%	43%

This chapter contains responses from participants which are presented in form of tables and charts, the second section contains discussion of findings. The discussion followed research objectives which included; To examine the level of awareness among small scale farmers on the effects of climate change; To determine the innovations used by small scale farmers in enhancing household food security; To establish agricultural strategies used by small scale farmers to reduce the effects of climate change and; To determine Government measures to be taken to reduce climate change effects.

4.1. Presentation of Research Findings

Respondents' background information

Different demographic characteristics like the gender of the household head, age of the household's head, and supplementary information such as the source of livelihood among others were studied.

Table 1 shows the gender of participants; 60 % were male-headed households while 40 % female-headed households.

Table 2 shows that the study was dominated by the age group between 41 and 50 years with 55 % of the total participants. This was followed by the age group 51 years and above at 43 % and the last group

Table 1: Gender

Gender	
Male	Female
60%	40%

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was between 35 and 40 years at 2 % of the total participants.

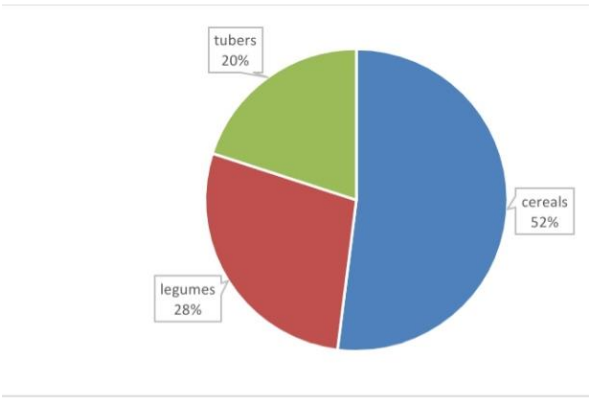
Regarding the main source of livelihood, 90 % of total respondents indicated that they completely depended on farming, 9 % depended on farming and also were doing some different small businesses, while 1 % depended on farming and formal employment.

Table 3: The main source of livelihood

The main source of livelihood		
Farming	Farming and Business	Farming and Employment
90%	9%	1%

Fig.1 shows farmers grow tubers, cereals and legumes and those who grow legumes represent 28% of total participants while those that cultivate more of cereals represent 52% and those who grow tubers represents 20% of total sample.

Fig.1. Crops farmers grow

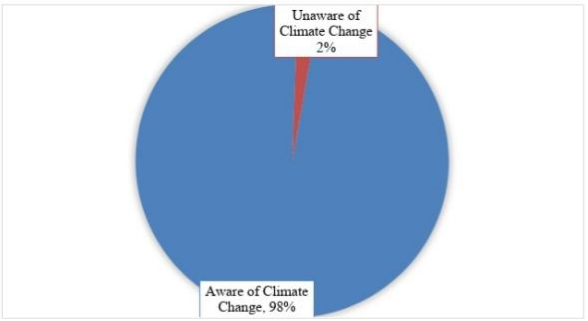


Farmers' awareness on climate change

Fig.2 shows respondents were asked about their knowledge concerning climate change and 98 % of the respondents were aware (60% were males while 38% were female) of climate change whereas 2 % were not sure.

Fig.2: Farmers awareness of climate change

Fig.3. shows half of the participants representing



60 % of the interviewed farmers indicated that climate change was caused by anthropogenic activities, and 18 % believed that climate change was caused by both human and natural actions. Whereas 12 % indicated that climate change was caused by nature, 6 % reported that climate change was due to supernatural forces (wrath of God), and the rest, 4 % said they were not sure of the causes.

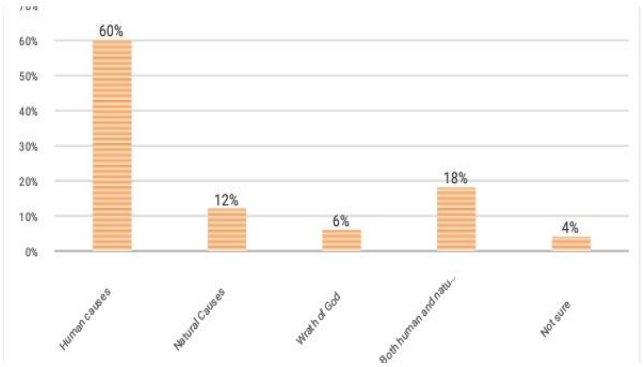


Fig.3: Perceived causes of climate change

Fig.4: shows the accessibility of extension services in the areas 66% of participants agreed that the services are available while 34% indicated that extension services are not available.

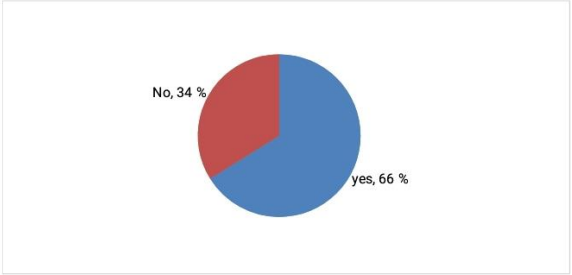


Fig.4: Accessibility of extension services

Table 4 below, portrays farmers who practice dry planting and dry season gardening comprise 70 % and 30 % of the respondents cited negative effects of climate change and source of income respectively. For instance, the unpredictability of the onset of the rainfall and the perceived short window period for planting influenced most of the farmers to dry plant. On the other hand, and due to demand for vegetables in the dry season some farmers focus on dry season gardening for a diversified and increase sources of income. Concerning agroforestry,51 % of the respondents who practice agroforestry (tree of field crop) cited the high cost of production inputs. Fertilizer has become more expensive for SHFs who are not on the farmer input support program (FISP) and 23 % stated that other factors like sources of animals' fodder and that trees left on croplands provided nutrients to the crops drive them to leave beneficial trees in the field strategically. The study also shows that most the farmers who use informal seed systems and recycled seed was an adaptation strategy to climate change. Over 45 % and 40 % of the farmers stated high cost of production inputs and negative effects of climate change respectively, as the main reason for using landrace seeds and recycled seeds. 40 % of those who shift to other areas for their farming activities cited the negative effects of climate change as the main reason for shifting. Regarding the reasons why farmers practice rotation as an adaptation strategy, 39 % cited the high cost of living and production inputs, 25 % said it was because of income, 19 % other factors, and 17 % climate change effects.

Table 4: Factors that influence SHFs' choice of adaptation strategies to climate change

Adaptation strategy	Negative CC effects	Income	High cost of living/production inputs	Other factors
Shifting to other areas	40%	30%	5%	25%
Seed recycling and use of landrace varieties	40%	-	45%	5%
Crop rotation	17%	25%	39%	19%
Multiple cropping	30%	35%	20%	15%
Dry season ripping and gardening	70%	30%	-	30%
Soil and water conservation	40%	33%	22%	5%
Agroforestry (Trees on cropland)	10%	7%	51%	23%

Innovations used by farmers

Concerning the effectiveness of the innovations used by small scale farmers to enhance household food security, Fig.5 shows that 18% said they are very effective, 48% indicated that they are effective while 26% said less effective and the rest 8% said they are not effective.

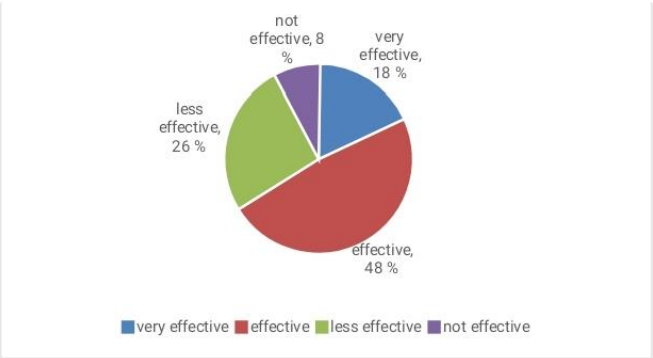


Fig.5: Effectiveness of the innovations used by farmers

Table 5. describes the different strategies used by farmer in mitigating the impact of climate change. In this study 10% of farmers apply conservation agriculture, 18% have adopted erosion control, 16% indicated that they have adopted grazing management, 8% have been using water storage systems to conserve water, 14% stated that they have adopted drip irrigation while 12% use new water management systems and the rest 22% have adopted early land preparation.

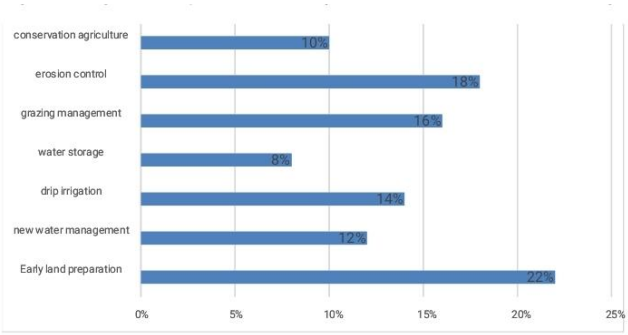


Fig.6. Different strategies used in mitigating effects climate change on farming

Strategies used by farmers

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Farmers are always adjusting their farming practices autonomously to suit changing climate. Table 5 indicated that multiple cropping was done by 29% of the total interviewed farmers, 26% used and recycle landrace varieties, 17% implemented agroforestry (by leaving trees on crop field), 9% relocated to other areas, 9 % plant at different times, 8% practiced dry season planting and gardening, while the remaining 4 % and 3% practiced crop rotation and other sustainable agriculture principles; and soil and water conservation and enhanced irrigation respectively. The respondents were required to point out the most prominent adaptation strategy they use from the strategies used as they cope with the effects caused by climate change. According to the participants, different strategies are adopted as farmers are adapting to the effects of climate change. Among all the strategies used by Small Scale Farmers, the most notable ones were multiple cropping, seed recycling and, the use of landrace seed varieties at 29 % and 26 % respectively. The least used adaptation strategies according to the study's findings were soil and water conservation/ enhanced irrigation and planting dates adjustment at 3 % and 4 % respectively.

Table 5: Adaptation strategies by local farmers

Adaptation strategy	Category of adaptation	% of farmers
Relocate to other areas	Area Specific or Local	9%
Recycling of landrace varieties	Area Specific or Local	26%
Crop rotation and other sustainable agriculture principles	Scientific	4%
Planting at different times	Area Specific or Local	9%
Multiple cropping	Area Specific or Local	29%
Dry season planting and gardening	Area Specific or Local	8%
Soil and water conservation and enhanced irrigation	Scientific	3%
Agroforestry (Trees on cropland)	Area Specific or Local	17%

Fig.7 shows the effectiveness of the strategies used by small scale farmers to enhance household food security; 10% said the innovations are very effective, 50% indicated that the innovations are effective while 20% said less effective and the rest 10% said they are not effective.

Fig.7: The effectiveness of farming strategies used to cope with climate change

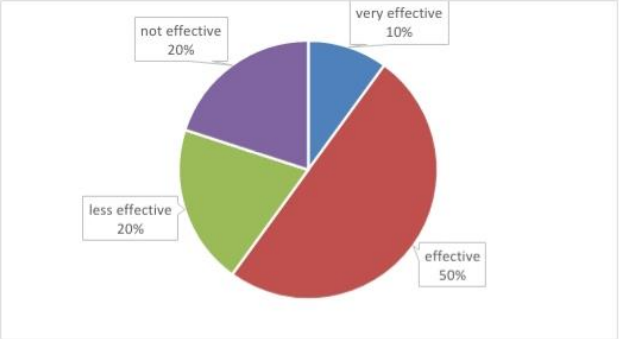


Fig.8. shows that small scale farmers some major constraints associated with adoption of climate change adaptation strategies farmers face. Interviewed farmers cited the high cost of production inputs (20 %) and inadequate knowledge of climate-related strategies (19 %) as reasons for not adopting strategies. Other reasons included poor access to meteorological information, limited resources including land, lack of skills and low literacy level, poor market, lack of veterinary services and poor extension services by 15 %, 10 %, 14 %, 12 %, 10% and 10 % respectively.

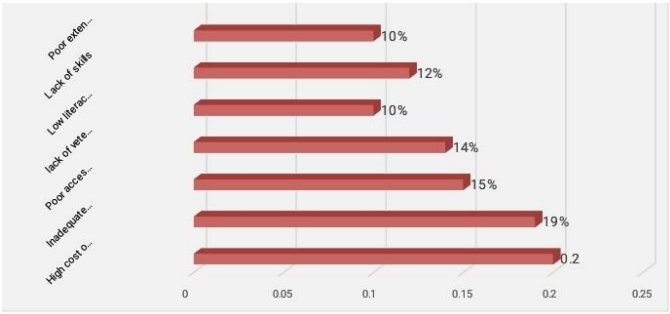
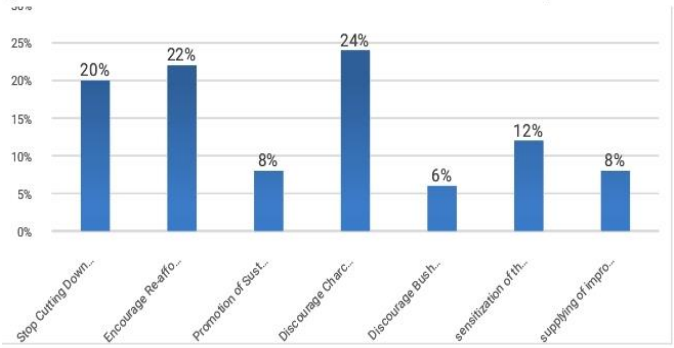


Fig.8. Challenges of adopting climate change adaption

Government measures to be taken to reduce the impact of climate change

In Fig.9 portrays that impacts of climate change suggested by the respondents were as follows; 20 % cited the call to stop cutting down trees with proper sensitization to the community members, 24 % stated the need to discourage charcoal burning and if there are alternatives to traditional charcoal to better be



considered and 22 % stated that there is a need to encourage re-afforestation, and the others; 8 % cited the need by the government to promote sustainable agriculture, 12% indicated that there is need of sensitizing the general public on the importance of reducing climate change while 8% said the government and other stakeholders to supply improved agricultural inputs which are climate change resilient and the remaining 6 % said that there is need to discourage bush burning especially the late one which is so destructive to the environment.

Fig.9. Government measures to be taken to reduce effects of climate change on farming

In Table 6 describes challenges farmers faced in implementing climate change adaptation strategies, interviewed officers cited the inadequate manpower (55 %) and insufficient transportation means (20 %) as reasons for not effectively implementing strategies. Other reasons included low literacy levels of farmers (10%); 5% claimed poor access roads to areas or farming blocks and 10% cited that farmers had no formal training of agricultural practices but depend on passed down information of forefathers which was not viable in this time of climate change.

Table 6: Challenges of implementing climate change adaptation strategies

Challenges faced by the department in delivering services	Inadequate manpower	Insufficient transportation means	Low literacy levels among farmers	Inaccessible roads	Lack of skills
Percentage of officers who cited this challenge	55%	20%	10%	5%	10%

4.2. Discussion of results

Concerning the application of innovations in coping with climate change, the following are some of the technological schemes used by small scale farmers: use mechanized irrigation which include the use of pumps, use of improved seed varieties in mitigating the impact of climate change, using precise irrigation schemes, use of improved disease control and advanced pest control management. Concerning the effectiveness of the technology used by small scale farmers to enhance household food security, 18% said they are very effective, 48% indicated that they are effective while 25% said less effective and the rest 9% said they are not effective. The technology if applied correctly has the capacity to enhance food security through increased production.

Study by Travis and Daniel (2010) indicates that new varieties and traits can also lead to less intensive use of other inputs such as fertilizers and pesticides and the associated equipment. In addition to increasing productivity generally, several new varieties and traits offer farmers greater flexibility in adapting to climate change, including traits that confer tolerance to drought and heat, tolerance to salinity (e.g., due to rising sea levels in coastal areas), and early maturation in order to shorten the growing season and reduce farmers' exposure to risk of extreme weather events. These promising new traits and varieties, which are mostly still in development, can emerge from traditional breeding techniques that leverage existing varieties that are well suited to vagaries of the local production environment as well as from more advanced biotechnology techniques such as marker assisted selection and genetic modification.

The study has revealed that almost all the farmers are aware of some changes that have taken place in the last ten years with regards rain pattern, temperature and general changes that have occurred. The level of awareness of climate change by farmers is believed to play an important role in shaping future actions on climate adaptation plans. The adoption of climate change adaptation measures depended on how adopters perceived climate change and its impacts. Thus, in this study farmers were asked about their knowledge concerning climate change and 98 % of the respondents were aware of climate change whereas 2 % were not sure of the changes that have occurred concerning climate change.

Concerning the level of awareness on climate change has been proven to be moderate as indicated by the respondents, 10% of the participants indicated that the level of awareness is very high, 28% indicated that the awareness level is high while 42% stated that the level of awareness is moderate while 16% said the level of awareness is low and the rest representing 4% stated that it has been very low. Therefore, as indicated by participants the level of awareness is moderate to high which proves that the knowledge concerning climate change is high on climate change.

Findings of the study by Elia (2017) revealed that farmers in the study areas were aware of climate change and variability. These findings are similar to those of Mertz, et al. (2008), the BBC World (Service Trust, 2010; Jonge, 2010; Kadi, et al. 2011). The farmers' awareness could have been created by the training carried out under the CCAA project. Training is one of the effective climate change information communication strategies which foster learning. Such training gives farmers a platform for seeking clarifications and feedback on farming activities related to climate change.

Results from the current study have shown that most of the adaptation strategies to climate change by SSFs are local-based knowledge as compared to scientific ones. As noted in Table 6, about 80 % of the interviewed farmers use area-specific adaptation strategies as compared to the scientifically based adaptation strategies with only about 20 % of the interviewed farmers using the methods. These findings are consistent with Ansah (2017) who reported that SHFs have a rich history of responding to climate change and its unpredictability. Ansah claims that area-specific adaptation practices help farmers cope with both current climate variability and future climate change (Ansah, 2017). The use of various agricultural adaptation strategies is usually necessitated by the anticipated different climatic shocks and exposure. As a result, a combination of several strategies is perceived to be more efficient than a single strategy (Legesse et al., 2013). It was worth noting that farmers within the same geographic area respond to climatic conditions in different ways and times. According to some respondents, this was due to differences in household demography, circumstances, and economic status.

Farmers use different adaptation strategies when responding to climate change effects. The most predominant ones are recycling of landrace seeds and multiple cropping which account for more than 50 % of the interviewed farmers. The commonly used adaptation strategies in the study area are classified as local knowledge-based. The local adaptation methods in this study are the interventions generated by individual farmers or groups locally to reduce the negative effect of climate change or to capitalize on the positive effect (Obaniyi et al., 2019). They are generated by indigenes or non-indigenes of a particular community through their interactions with nature or trial and error mechanisms (Mafongoya, 2017).

Farmers use different agricultural practices in mitigating the impact of climate change, in this study, some of the means used are application of conservation agriculture, erosion control, grazing management, water storage systems to conserve water, drip irrigation, use new water management systems and the rest early land preparation. These

means have proven to be effective in enhancing household food security amid adverse effects of climate change.

Concerning the effectiveness of the practices used by small scale farmers to enhance household food security, 10% said the innovations are very effective, 50% indicated that the innovations are effective while 20% said less effective and the rest 10% said they are not effective. This shows that the agricultural practices being applied by small scale farmers in the farming blocks are effective. Dinesh et al., (2021) said farmers in the Algerian Sahara devised a number of techniques to combat the effects of drought, on the one hand, and the pressures on water resources from other sectors such as the extractive industry, on the other hand. A good example is the widespread practice of sustainable use of water in potato crop production in the El Oued region (southeast of Algeria).

Climate-smart agriculture (CSA) has been identified as an important tool that can be used to overcome the challenges presented by climate change to agricultural systems and better incorporate agriculture in international climate negotiations (Andrieu et al., 2021). Indeed, CSA enables farmers, key institutions and service providers to farmers build the capacity to adapt and effectively respond to long-term climate change as well as manage the risks that come about as a result of increased climate variability.

Several measures that could address some of the impacts of climate change were suggested by the respondents of the current study. Among the suggestions by the respondents were: the call to stop cutting down trees with proper sensitization to the community members, discourage charcoal burning and if there are alternatives to traditional charcoal to better be considered and encourage re-afforestation, and the others; government to promote sustainable agriculture, 11% indicated that there is need of sensitizing the general public on the importance of reducing climate change, government and other stakeholders to supply improved agricultural inputs which are climate change resilient and discourage bush burning especially the late one which is so destructive to the environment.

There is need for government and other stakeholders to facilitate concerted efforts to develop more robust climate change adaptation mechanisms to reinforce existing and promising local coping initiatives. To some extent this is already happening in central and southern Zambia as government, PELUM and other partners (e.g. Harvest Help Zambia and ESAFF) including other players are promoting initiatives to improve rural farmers' resilience to climate change. The strategies being promoted include water harvesting and storage technologies, small scale water lifting devices for crop irrigation, solar energy as an alternative to fuel wood and low external input farming techniques such as conservation farming and agroforestry (DFID, 2004).

Although the poor farming communities in parts of central and southern Zambia, assisted by government, NGOs and other stakeholders are striving to better adapt to climate change, much more still needs to be done. The effectiveness of any climate change adaptation initiatives will depend upon strategic collaborative efforts and partnerships across all sectors, interest groups, geographic and socio-economic boundaries. The international, government agencies and local communities should partner and work closely together in devising initiatives that would help to consolidate existing knowledge and generate new information on climate change to facilitate informed decisions on what could be possibly done beyond individual or household actions. Equally important is the need for governments, development partners and other stakeholders to deliberately and proactively mainstream climate change in development plans to try and avoid emergency situations or the desperate and ineffective responses to emergencies when the emergencies inevitably occur (DFID, 2004).

4.3. CONCLUSION AND RECOMMENDATION

Overview

The main conclusions and recommendations of the study are outlined in this chapter. These are in line with the main aim of the study which was to exam the effectiveness of climate change coping strategies in enhancing household food security. The conclusion was based on the specific objectives.

Conclusion

This research aimed at examining the effectiveness of climate change coping strategies in enhancing household food security. The results have shown how agriculture plays a key role in supporting livelihoods of the people. This is despite being affected by climate change risks and shocks. It is quite evident that agricultural activities in Petauke have not been exempted from the catastrophic negative effects of climate change. It has been shown from the study that most of the farmers use area specific knowledge-based adaptation strategies as they respond to the climatic changes. The commonly applied agricultural adaptation strategies include multiple cropping, informal seed systems, traditional agroforestry, dry season gardening and dry planting.

The study has further shown that farmers in use several and different combination of strategies which are innovation and technology based. These strategies are linked to on-farm activities and based on both local knowledge and scientific knowledge-based strategies for their farming activities. However, majority of the farmers use local knowledge-based adaptation because they do not have accurate source of information about climate/weather and accurate interpretation that would help them in their decisions. The choice of adaptation strategies by farmers is normally influenced by several factors both at household and community levels. It is therefore important that careful considerations are well-thought-out to ensure that factors that influence farmers' choice of adaptation are addressed in the design and implementation of climate change adaptations support. This has the potential to enhance the effectiveness of adaptation strategies to reduce the vulnerability of farming households to climate variability. Farmers use different innovative means in mitigating the impact of climate change, in this study, some of the means used are application of conservation agriculture, erosion control, grazing management, water storage systems to conserve water, drip irrigation, use new water management systems and the rest early land preparation while Concerning the application of technology in coping with climate change, the following are some of the technological schemes used by small scale farmers: use mechanized irrigation which include the use of pumps, use of improved seed varieties in mitigating the impact of climate change, using precise irrigation schemes, use of improved disease control and advanced pest control management. The study has further indicated that the strategies used by farmers to cope with the changes in climate are effective if applied accordingly, these strategies have helped small scale farmers to enhance household food security.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Government ought to develop strategies on how Meteorological Department in collaboration with the Ministry of Agriculture can improve localized information delivery on weather and climate change to the farmers.
2. There is need of involving key stakeholders which will enhance the dissemination of correct and timely climate and weather information to small scale farmers more preferably translated into the local language.
3. The government ought to discourage charcoal burning by encouraging alternative sources of energy for cooking e.g. gas stove, cow dung, cheaper solar equipment; and fining charcoal

vendors to discourage the charcoal business from growing.

4. Government and partners need to fund more scientific strategies among farmers through acquisition of more transportation vehicles like bicycles and motorcycles for extension officers to reach farmers regularly and fund farmer groups with equipment like pumps for irrigation.

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